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Teacher Preparation and Student Achievement: Reviewing the Evidence

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Executive Summary

A review of existing quantitative research linking teacher preparation program characteristics to student achievement suggests the following conclusions, several of which are preliminary given the developing state of this body of work:

- It seems simple, but the best teacher preparation programs design their offerings around the goal of *teaching teachers how to teach*. Frequent opportunities for pre-service teachers to gain practice—within coursework and in the field—with the techniques and kinds of students they are likely to work with in the future are associated with greater student achievement gains in those teachers' classrooms. Unfortunately, many teacher preparation programs feature ineffective requirements (e.g., foundations courses) that crowd out opportunities for gaining such experience.
- Subject matter content preparation for teachers is important in more technical subjects such as math and science. However, there is little evidence that content preparation is linked to student achievement in other subjects.
- The impacts of math and science content coursework are not universal. Research suggests that the majority of benefits are obtained from a relatively small number of content course requirements—perhaps five—with benefits leveling off for additional courses. These courses are more effective when linked explicitly to teaching practice (i.e. math *education* courses appear to be more important than math courses). Also, the impact of content coursework is larger for some students (e.g., Advanced Placement) than others (e.g., remedial).
- Coursework and preparation in pedagogy is positively linked to student achievement. Such preparation appears to be more effective when (a) tied to content knowledge and (b) linked to opportunities for practice. However, little work exists to suggest precisely what pedagogical skills and practices preparation programs should teach.
- Field experiences are central to teacher preparation. The most effective field experiences are closely coordinated and monitored by the preparation program to ensure quality. Teachers gain more from field experiences when they are in the same subject and grade level as the teacher's future teaching assignment.
- Alternative certification programs can be just as effective as traditional teacher preparation programs at producing effective teachers, so long as they undertake approaches geared towards linking preparation to teaching practice.
- There is far too little rigorous research into the most effective practices for teacher preparation programs. A major difficulty is the capacity to link program characteristics and practices to teachers and then to student value-added. Fortunately, Missouri has made a substantial investment in the latter through its investment in its longitudinal data system. Further investment in collecting and linking in teacher preparation program data and conducting rigorous analysis of the resulting data set not only would yield benefits to Missouri, but also could position the state as a national leader in the areas of teacher preparation policy and research.

Introduction

Much of the research base linking teacher preparation to student achievement has focused on generalities: type of program completed, type of degree obtained, type of certification received, and so forth. Such studies have underscored the conclusion that there is much more variation *within* pathways to the classroom than *between* them. That is, knowing whether a teacher completed a traditional preparation program or received a regular certification is less useful for predicting his or her effectiveness than knowing what kinds of pre-service experiences the teacher had.

Lamentably, research examining the critical question of what kinds of pre-service experiences teachers need—i.e. how teacher preparation programs should be designed—to make them more effective is in short supply. The main impediment traditionally has been a scarcity of data. Large databases containing teacher preparation program characteristics that could be linked to teachers and their students have not existed. As a result, research on teacher preparation program characteristics is generally sparse, often qualitative, and only occasionally linked to student achievement data.

Fortunately, teacher preparation program characteristics and practices have begun to come under greater empirical scrutiny in recent years, and some conclusions—many tentative or preliminary—can be drawn from this relatively nascent body of work. The goal of this review is to summarize and draw implications from existing empirical research on the impact of formal teacher preparation on student achievement. One important conclusion we draw from this review is that a great deal of research is left to be done. With appropriate attention to data collection and analysis, Missouri can draw on its existing investment in longitudinal teacher and student data and the substantial variation in its preparation routes and programs to become a national leader in research into best practices in teacher preparation.

Method and Focus

In identifying studies to be included in this review, we limited ourselves to studies that satisfied several key criteria.

1. *Quantitative in nature*. We include only studies with large enough samples to be analyzed statistically. While we do not discount the usefulness of qualitative methodologies such as case studies and narrative analysis, we limited ourselves to quantitative studies to make the review manageable and to increase our confidence in the validity and generalizability of the findings.
2. *Rigorously analyzed*. We include only studies that employ multivariate data analysis methods (e.g., multiple regression). Simpler statistical methods prevent the analyst from being able to control for key variables, such as student characteristics or the school environment, which may confound estimates of the associations between teacher preparation characteristics and student outcomes, limiting the validity of such studies.
3. *Specific link to student achievement*. We include only studies that consider student achievement as an outcome variable.[1] This choice reflects

[1] A few studies included in the table at the end of this report use principal evaluations of teacher practice rather than student test scores, though we do not draw on those studies in the summary in the next section.

the focus on the demonstration of student learning embedded in current federal and state policies. A large number of studies use more readily available outcomes, such as teacher survey evaluations of their own teaching practice; however, such measures may or may not be closely linked to how much students learn, making them less useful for evaluating the effectiveness of teacher preparation practices.

Limiting ourselves to studies meeting these three criteria meant that *recency* also became a characteristic of the papers we include. Only in the last two decades have we begun to develop the kinds of data sets that allow us to link characteristics of teachers and their training to students and student outcomes in a rigorous way. As a result, nearly all of the studies we review here were published since 1990.

Our review of relevant studies draws heavily from three prior reports that synthesized prior work on teacher education, which we used to help us identify studies meeting the criteria above. The first is the book *Studying Teacher Education*, a book-length report of the Panel on Research and Teacher Education commissioned by the American Educational Research Association (AERA). This report, published in 2005, was edited by Marilyn Cochran-Smith (Boston College) and Kenneth Zeichner (University of Wisconsin–Madison). The second is a report published in 2001, *Teacher Preparation Research: Current Knowledge, Gaps and Recommendations*, prepared for the U.S. Department of Education by the Center for the Study of Teaching and Policy at the University of Washington. The report was edited by Suzanne Wilson, Robert Floden, and Joan Ferrini-Mundy, all of Michigan State University. Third is a report published in 2006 and prepared by Michael Allen, program director of the Education Commission of the States, through a grant from the U.S. Department of Education. We supplemented the sources we identified from these three reports with additional literature searches, concentrating primarily on the period following the Allen review in 2006 to ensure that our review is as up-to-date as possible.

Organization of This Review

The main section of this review is the next one, which summarizes in narrative form the recent empirical research on the link between teacher preparation and student achievement. This section is divided into subsections that reflect the central topics examined in this body of work: subject matter preparation, pedagogical coursework and practices, field experiences, and alternative certification. Following the summary, we include a section that draws on the research we examined to make recommendations for Missouri preparation programs. We then include a complete list of references for all studies included in the study. The final two sections repeat a subset of these references with additional detail. We annotate the most important studies in the review with more complete notes about data sets utilized, methodologies employed and conclusions drawn. We then include a table with more basic information about studies that were less central to our review. The majority of these studies were drawn from research syntheses conducted by Wilson, Floden, and Ferrini-Mundy (2001) and Allen (2006).

Research on Teacher Preparation and Student Achievement

Teacher preparation matters. As an exemplary study of New York data by Boyd et al. (2009) notes, attending a high-quality teacher preparation program can add the equivalent of *one full year of teaching experience* for the average teacher relative to attending a program of lesser quality. However, identifying the *characteristics* that differentiate high-quality programs from low-quality programs is a difficult endeavor with existing data. Thus, in building a summary of rigorous empirical research on the impact of teacher preparation programs on student achievement, one quickly reaches the conclusion that there simply are too few strong studies examining the kinds of policy-amenable characteristics that state and local policymakers are likely to care about. Here we synthesize the evidence that does exist, grouped by the primary theme areas that researchers have tended to examine in this literature.

Subject Matter Preparation

As Cochran-Smith and Zeichner's (2005) report for AERA notes, "there is very little research on the impact of subject-specific study on learning" (11). The primary exception is in mathematics. In general, subject-specific content preparation appears to have a positive relationship to student achievement, but the effect varies not only by subject but also by grade and level of preparation required. As a result, broad conclusions are difficult to draw. Even in mathematics, where the strongest evidence of a relationship exists, the specific *content* of math courses that leads to the highest student achievement gains has yet to be determined.

Mathematics preparation. Numerous studies find a moderate positive correlation between a teacher having substantial preparation in mathematics and students' math test score outcomes. In a synthetic review article published in the *Review of Educational Research*, Wayne and Youngs (2003) conclude that the weight of the evidence suggests that math-specific coursework for pre-service teachers translates into higher gains in math achievement, though they point out that much of this evidence has been gleaned from studies of high school and not elementary school students. Specifically, teachers with bachelor's degrees or master's degrees in math tend to produce higher math gains for students than teachers with degrees in other fields (Goldhaber & Brewer, 1997; Goldhaber & Brewer, 2000; Eberts & Stone, 1984; Rowan et al. 1997; Monk & King, 1994). In addition, Goldhaber and Brewer (1997) find that students gain more under teachers certified in math as compared to teachers with no math certification.

Using national longitudinal data from 1987 to 1990, Monk (1994) finds that the number of math content courses a teacher had in his or her undergraduate coursework had a positive relationship to student achievement. Each additional math content course correlated with a 1.2% increase in mean student test scores for juniors and a 0.2% increase for sophomores. A similarly positive effect was found for math education coursework. However, Monk noted several additional wrinkles. First, the positive impact of math education coursework was larger than for math content coursework. Second, the relationship between math content coursework and student achievement appeared to be curvilinear. Monk found that beyond five content courses, the additional

impact of further math courses on teachers' student value-added is essentially flat, suggesting that a relatively small number of math content courses may be optimal for most math teachers. Third, the number of math courses taken differentially impacted different kinds of students, with a large effect on students in Advanced Placement (AP) courses but no effects on students in remedial courses. Finally, majoring in math had no *independent* effect on student achievement once course taking was accounted for. This controlling for course taking may explain why Monk finds no "math degree" effect, which other studies have found (e.g., Chaney, 1995; Hawkins, Stancavage, & Dossey, 1998).

More recent studies have confirmed the importance of math content preparation. In their longitudinal study of new teachers in New York City, Boyd et al. (2009) find that teachers from programs with larger numbers of math content requirements have higher student value-added (approximately 0.02 standard deviations per course). Importantly, these authors examine test scores for 4th through 8th graders, providing evidence of the importance of math content for elementary and middle school students. Kukla-Acevedo (2009) examines data from 5th graders in one school district in Kentucky and finds positive impacts of teachers have more math content hours, with the effects growing as teachers gained teaching experience. The study also finds positive effects of math education hours, though the effects tended to be concentrated in more experienced teachers.

Science preparation. Several studies have also found positive impacts of science content preparation on value added in science. For example, Goldhaber and Brewer (1997) find that teachers with bachelor's degrees in science produce higher value-added in test scores of the teachers' tenth grade students in science. In another study, Goldhaber and Brewer (2000) find that holding a BA in science had no correlation with student science performance, while holding a BA in education had a negative correlation.

Monk (1994) also considered the contribution of subject-specific preparation in science on student achievement. Positive impacts in high school were found for number of courses in both life and physical sciences, but importantly, these effects were not evident until teachers had taken 4–6 preparatory courses. Positive effects were also found for science pedagogy courses, with effect sizes twice as large for science pedagogy as science content courses. Interestingly, Monk finds positive impacts of number of math courses taken on student achievement in the physical sciences as well, suggesting that math content knowledge can be helpful for science teaching. Cochran-Smith and Zeichner (2005) describe Monk's findings as consistent with older studies. However, it is important to note the limited exploration of science content preparation to date, especially at the elementary and middle school levels.

Preparation in other subjects. The impact of subject-specific preparation in subjects other than math and science generally has been found to be weak, though Cochran-Smith and Zeichner (2005) note that the body of work on subjects outside of mathematics is too small to be conclusive (12). Goldhaber and Brewer (1997) examine English and history degrees and certification for teachers and find no impact on student learning. Boyd et al. (2009) find some positive value-added impacts of ELA course requirements on ELA student test scores in New York, though they are concentrated in

second-year rather than first-year teachers (in fact, there is a negative correlation for first-year teachers).

The general conclusion from this body of research is summed up by Goldhaber and Brewer (1997) as indicating, "that student achievement in technical subjects can be improved by requiring in-subject teaching" (208). Monk (1994) similarly observes that "the effect of teacher subject matter knowledge appears to depend on the subject being taught, the characteristics of the students being taught, as well as on additional attributes of the teacher" (142). These effects might be enhanced when content is tied specifically to pedagogy, as when students take math education courses. However, there does not appear to be much evidence that subject-specific coursework is important for teachers of other subjects. Also, as Floden and Meniketti (2005) point out, even the positive correlations observed between math preparation and student math achievement might not mean that preparation in math *causes* greater math achievement, since it could be the case that, for example, teacher candidates who take more math courses might also be more enthusiastic about math or have greater innate aptitude for math, which then drives teaching effectiveness in the subject (266). Still, the weight of the evidence suggests some positive effects of content preparation in the more technical subjects.

Pedagogical Coursework and Practice

Most research on the effect of pedagogical knowledge examines the association between education coursework and student achievement. For example, as already noted, Monk (1994) finds positive effects of having multiple math and science education courses (i.e. courses designed to teach how to teach those subjects) on student outcomes in math and science. Monk also notes that math education coursework adds more to student gains than simply math content courses. Chaney (1995) finds that pedagogical coursework only adds to student achievement when tied to the content area, i.e. general education courses did not add to student achievement. Kukla-Acevedo (2009) also finds positive impacts of math pedagogy courses on students' math achievement.

While studies confirm that pedagogy and teaching methods matter for student achievement (e.g., Wenglinsky, 2002), research linking *actual teaching methods* to student achievement is scarce. Still, the few results that exist are generally positive.

In perhaps the most rigorous study available linking teacher program characteristics to student outcomes, Boyd et al. (2009) find that preparation programs with a focus in the curriculum on teacher practice produce first-year teachers with higher student value-added in both math and ELA. In their study, "focus on practice" meant the availability of opportunities to engage in practical experiences inside and outside the classroom, such as listening to individual children reading aloud for the purpose of assessing his or her reading achievement, planning a guided reading lesson, or analyzing student math work. In fact, a one standard deviation move in this focus on practice was equivalent in their study to roughly one additional year of teaching experience in terms of teacher effectiveness, a very large difference.

Another finding in the Boyd et al. (2009) study was that programs in which pre-service teachers studied the specific curriculum that they would be implementing as teachers in the New York City school system yielded teachers with more positive math

and ELA test score gains. The opportunity to think through and practice with the actual teaching program appeared to prepare teachers to implement it more effectively.

Boyd et al. (2009) also found that programs featuring greater opportunities to learn specific math teaching strategies (e.g., to learn typical difficulties students have with fractions) were associated with math gains in the second year of teaching (though not the first). However, the link to pedagogy was limited to math; no such impact was found for the study of ELA teaching strategies for first- or second-year teachers in New York City.

In general, Allen's (2006) assessment of the existing literature suggests that knowledge of pedagogy appears to be important but that precisely what skills teachers need and where they are most effectively learned (e.g., in the field, in coursework) is unclear. Wilson, Floden, and Ferrini-Mundy's review (2001) suggests that pedagogical coursework appears to matter more to student achievement than other teacher preparation characteristics, including subject-area coursework, but also points out that existing studies do little to provide details as to what such courses do or should teach.

Field Experiences

As Clift and Brady (2005) note, "impact, thus far in the evolution of teacher education research on…field experiences, is almost exclusively defined in terms of preservice teachers' conceptions of the content area, teaching and learning processes, and their ability to translate concepts into actions" (330). In other words, few studies exist that specifically link field experiences to student achievement. Moreover, since characteristics of field experiences programs offer vary widely, it would be difficult to draw many conclusions from existing qualitative research about the effects of *field experiences* writ large.

However, one important quantitative study bears mention in this section: the Boyd et al. (2009) study of beginning teachers in New York City. Among the teacher preparation programs these teachers attended, virtually all had field components, leaving no variation with which to link participation in a field experience to student outcomes. Nevertheless, the study found important contributions of the *quality* of those field experiences. In particular, the authors identified positive impacts on test score gains in both math and ELA in the first year from programs maintaining what the authors call "oversight of the student teaching experience." This measure combines three highly correlated sub-measures:

- whether the program requires that cooperating teachers have a minimum number of years of teaching experience;
- whether the program picks the cooperating teacher, as opposed to selection by the K–12 school or the student teacher; and
- whether a program supervisor observes the participants at least five times during student teaching.

In other words, teachers appear to learn more when the program closely coordinates and monitors their student teaching experiences to ensure some degree of quality.

The authors also uncovered a separate effect on student achievement of what they term "degree of congruence" between field experience context and context of current teaching job, at least for first year math teachers. *Congruence* means that student teaching is done in the same subject and at the same grade level as the teacher's first

post-completion teaching assignment. Teachers gain effectiveness as they gain additional practice in the specific context in which they will teach.

As a related point, Boyd et al. (2009) also found a positive association in the first year of teaching for both math and ELA value-added of the teacher preparation program requiring a capstone project (e.g., portfolio or research project). Only about half of the NYC programs had such a requirement. Moreover, these effects were quite large, i.e. worth about the same as two math content courses for a first-year math teacher. The authors explain this "capstone effect" as proxying for the program grounding its preparation approach in the practice of teaching, which they argue is the hallmark of effective teacher preparation.

Foundations of Education and Other Coursework

Another common component of teacher preparation programs are courses often termed *foundations courses*, i.e. courses with no specific tie to teaching practice but that are thought to prepare preservice teachers to understand education as a field. These include such courses as educational psychology, social-philosophical education studies, and the history of education.

Unfortunately, education scholars have done little research that examines the presumption that teachers need such courses. In their contribution to the Cochran-Smith and Zeichner AERA volume, Floden and Meniketti (2005) called evidence on the impact on student learning of such courses "scant" (284), uncovering no studies that link foundations courses to student test performance. However, the Boyd et al. (2009) study, published after the Floden and Meniketti review, did examine the impact of some foundations requirements. They find no significant associations between course taking focusing on the stages of child development or learning theory on either math or ELA value-added. In fact, programs with more emphasis on these topics actually were correlated with *negative* value-added in some specifications. One possible explanation is that programs with larger numbers of foundation course requirements leave less space in the curriculum for the practice courses that are most associated with increasing teacher effectiveness.

Another area of coursework common to teacher preparation programs are general education requirements in the arts and sciences. Again, no link has been made between such courses and student achievement. In fact, in their review, Floden and Meniketti (2005) uncovered not a single rigorous study linking general arts and sciences course requirements to student outcomes.

Licensure Examinations

Missouri, like most states, requires teachers to pass a licensure examination as a component of the certification process. Synthesizing four studies of teacher licensure, Wayne and Youngs (2003) conclude that in fact students do learn more from teachers with higher test scores on teacher licensure examinations. However, Cochran-Smith and Zeichner (2005) caution that most research on teacher testing is outdated, focusing on tests that are no longer in active use. They also conclude that "there is little evidence that such tests have predictive validity—that is, there is little evidence that there is a relationship between teachers' scores on such tests and their teaching success (measured in terms of teacher behavior, principal ratings, or student achievement)" (26).

A very well-designed study by Goldhaber (2007) conducted after the Cochran-Smith and Zeichner compendium was published stands in contrast. Goldhaber linked administrative data on student test scores from grades 4-6 and teacher Praxis II content and curriculum test scores in North Carolina from the 1994-1995 through 2003-2004 school years, then uses a rigorous fixed-effects regression design to estimate the predictive validity of Praxis II scores on student value-added in reading and math. Goldhaber found that Praxis II Curriculum, Assessment and Instruction scores indeed positively predicted student achievement. In particular, a teacher scoring at the 80th percentile on this part of the Praxis II examination would have student test score gains that were, on average, 0.022 standard deviations higher in reading and 0.035 standard deviations higher in math than a teacher scoring at the 20th percentile. However, Goldhaber found that Praxis II Content scores had no relationship with student value-added in either subject. The disparate findings for the two sections of the exam leads Goldhaber to the conclusion that knowledge of curriculum planning, assessment of student learning and other teaching skills is more important than content knowledge for student achievement.

Other recent studies have corroborated the Goldhaber (2007) findings. As Boyd, Goldhaber, Lankford, and Wyckoff (2007) note, two other recent studies (Clotfelter, Ladd, & Vigdor, 2006; Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2006) find a positive relationship between licensure exam scores and student achievement.

Alternative Certification

Research generally favors the conclusion that certified teachers perform at higher levels—as measured by student achievement—than teachers with no or emergency certification (Fetler, 1999, Cochran-Smith & Zeichner, 2005, 26). However, there are multiple ways in which teachers can become certified. In particular, the widespread growth of alternative certification programs as means for states to attract non-traditional teachers to classrooms has made them the focus of some attention in the teacher preparation literature. One observation that grows out of such studies is that the significant variation among alternative certification programs makes it difficult to make generalizations about the alternative certification pathway, or even to delineate a clear pathway at all.

However, studies of specific alternative certification programs generally find few differences between alternatively certified teachers and traditionally prepared teachers with similar in-service experiences (Goebel, Ronacher, & Sanchez, 1989; Hutton, Lutz, & Williamson, 1990; Miller, McKenna, & McKenna, 1998; Raymond, Fletcher, & Luque, 2001). Unfortunately, these studies do little to identify effective program characteristics.

Comprehensive work by Boyd et al. (2006) comparing traditionally and alternatively certified teachers in New York City suggests that teachers entering through alternative pathways such as the NYC Teaching Fellows Program performed slightly worse than college-recommended teachers in their first year but in some cases outpaced those teachers by years 2 and 3. Importantly, alternative routes in NYC emphasize some features (e.g., substantial field experiences) already identified as important for improving teacher effectiveness. However, the authors note that much work is left to be done in figuring out what alternative program attributes are most central.

Recommendations Based on Empirical Evidence

The existing research base on the link between teacher preparation program characteristics and student outcomes suggests several steps that Missouri can take to ensure high-quality teacher preparation that translates into effective teaching and, in turn, more positive gains in student achievement. Here we draw on this evidentiary base to outline a few recommendations.

1. **All teacher preparation program components should be grounded in teaching practice.** The evidentiary base strongly supports the idea that pre-service teachers gain substantially from more frequent and higher-quality opportunities to gain hands-on experience, explore teaching methods, practice with curricula, and encounter situations and challenges they are likely to confront after the preparation program has ended. Preparation program coursework requirements likely can be streamlined in some areas (e.g., foundations courses) to make room for more practical courses and experiences.

2. **Students need high-quality field experiences.** This point is related to the first. Most programs feature field experience requirements; what separates them is how those field experiences are structured to maximize what pre-service teachers can learn from them. The field experience should have explicit goals that are linked closely to teacher practice. Cooperating teachers should be selected carefully. The preparation program should monitor the experience closely, with frequent contact with the student and cooperating teacher.

3. **Teacher content knowledge should be emphasized in mathematics and science but perhaps not in other subjects.** There is good evidence that teachers of math and science perform better with more extensive grounding in those subjects. However, it may be preferable to substitute math and science courses with math and science *education* courses that both teach content and emphasize the link to teaching strategies. Moreover, there is no good evidence of a content knowledge effect in less technical subjects (e.g., social studies). It is likely that coursework devoted to teaching practice or pedagogy would be a more productive use of student time, if the goal is improving student achievement.

4. **Pedagogy matters, but how students learn it is as important as what is taught.** Pedagogy should be tied to the content area the teacher will be teaching in the future, and should be grounded in actual classroom skills. Students should acquire hands-on experience with pedagogical techniques, through field experiences, a capstone, or practice in the classroom. Again close and explicit ties to the actual practice of teaching appears to make pedagogical coursework substantially more effective.

5. **Teacher preparation programs should be judged by their outputs rather than their inputs.** In the era of accountability, education has begun to move beyond being satisfied with the counting of inputs: dollars, certified

teachers, curricular programs, and the like. A premium now is placed on outputs, primarily student learning. A similar principle can guide standards for teacher preparation. Studies suggest that there is great variation in program structures and program offerings, even within the same state. We know too little about how preparation programs should be structured to impose standards for inputs or offerings beyond some minimum. Instead, we likely can benefit from encouraging experimentation and innovation in preparation program structure and curriculum in both traditional and alternative routes but holding programs accountable for the quality of the teachers they produce. States like Louisiana already are taking such an approach, evaluating preparation programs on student achievement gains in major content areas (Noell, Porter, Patt, & Dahir, 2008). Coupling such evaluation with a willingness to question existing practice and scrap what does not work is a good strategy for overall program improvement.

6. **Alternative certification programs should also focus on employing strategies identified here as linked to student achievement.** Most of the recommendations made here can be and are incorporated by alternative route programs. In fact, several studies reviewed here incorporate alternatively certified teachers explicitly into their research on preparation program effectiveness (Boyd et al., 2009). Several of the features of strong programs, such as the focus on hands-on experience, are already at the center of many alternative certification programs. As alternatively prepared teachers grow in number, it will become even more important for them to focus on preparation strategies linked specifically to student achievement.

7. **DESE and the Missouri teacher preparation community should encourage and support an in-depth research program on teacher preparation to promote continuous improvement in the state's teacher preparation offerings.** If there is any strong conclusion to be drawn from the foregoing research review, it is that there is a STRONG NEED for rigorous research on how teachers are prepared to enter the classroom. As one set of authors put it, "what is most remarkable today is the lack of evidence on the effect of almost any aspect of teacher preparation on the performance of students" (Boyd et al., 2007, 59). There is a real opportunity for Missouri to become a national leader in this area**.** The ongoing research program of Boyd and coauthors in New York provides a very good model. Data collected for that research includes a mix of information collected about and from teacher preparation programs and survey data from teachers eliciting characteristics of their training experiences, which are then linked to administrative data on schools and student achievement. Missouri has invested substantially in collecting much of these kinds of data already; the challenge is coordinating these efforts to make comprehensive data sets available to researchers for rigorous analysis. Such analysis could have large benefits for Missouri students, since the results can be used to promote continuous improvement in Missouri's teacher preparation offerings. Investing in such an effort would have spillover effects in other states as well, given how little existing evidence states have to go on in designing effective teacher preparation.

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- Type of Study: Meta-analysis
- Data Sources:
    - Meta-analysis of 92 empirical studies, including 52 peer reviewed articles from scholarly journals and 40 other studies deemed high quality, such as longer reports and books not published in journals.
- Study Design: The study examines eight main research questions on teacher preparation: subject matter coursework and degrees, pedagogical coursework, field experience, strategies for hard-to-staff schools, the stringency of entrance requirements, the effect of accreditation, and institutional warranties for new teachers.
- Summary and Results:
    - The purpose of the study is to examine eight distinct policy areas in teacher preparation to guide researchers in directing future studies as well as to help policymakers make more informed policy decisions about teacher preparation.
    - The paper has four main findings relating to teacher preparation characteristics:
    - Subject matter preparation: Moderate support specifically in mathematics courses, but current research is not detailed enough to know how much knowledge is appropriate for teaching certain courses or grades
        - Major in subject area: Inconclusive, effects found have been small and the advantage over coursework without a degree in the subject area is unclear; a point may exists when more courses are not valuable
        - Graduate degree in subject area: Research is too limited to be conclusive, only four studies have examined this question and three could not separate undergraduate from graduate degree effects, the fourth study found negative results for elementary students
        - Subject-specific education courses: Limited support in the research base
    - Pedagogical coursework: Limited support in the research base, knowledge of pedagogy appears to be important but precisely what skills and where they are most effectively learned (in the field, on the job, in coursework) is unclear
        - Connection to student achievement is noted as weak and often reliant on qualitative studies
    - Field experience: All studies of field experiences included in this analysis were descriptive and relied on teachers' perceptions of changes in their practices and beliefs, and thus are inconclusive as to the effect on student achievement.
        - Some characteristics of high-quality field experiences noted by the studies were summarized in the analysis, though their relationship

to student achievement has not been confirmed. These include grasp of subject, practical pre-placement coursework, classroom management training early in the experience, well-trained cooperating teachers that give students responsibility and autonomy, reflection is encouraged, faculty supervision of students in addition to cooperating teachers, interaction with other students completing the experience, a well-organized experience, and a variety of field experience choices.
    - The authors' main conclusion is that more and better research on teacher preparation is needed and such research should be developed in cooperation with the policy community who should utilize its findings when implementing reforms.
- Notes/Ideas/Insights:
    - The paper provides a comprehensive overview of several key characteristics of teacher preparation in the last 20 years, indicating where research is thin and noting methodological deficiencies when drawing inferences.

Boyd, D., D. Goldhaber, H. Lankford, and J. Wyckoff. (2007). The effect of certification and preparation on teacher quality. *Future of Children* 17(4), 45-68.

- Type of Study: Meta-analysis
- Data Sources:
    - The paper examines value-added student achievement data in previous studies.
- Study Design: The study compiles findings from previous studies on teacher preparation and certification exams and their effects on student achievement.
- Summary and Results:
    - The paper summarizes research on the effects of teacher preparation programs, certifications exams, teacher supply policies, and hiring practices on student achievement. Specifically related to preparation programs, the study asked, "to what extent do the knowledge and skills provided in teacher preparation programs improve teachers' ability to raise achievement for students?" (Boyd et al. 2007, 55).
    - The paper has three main findings relating to teacher preparation programs:
        - Subject specific coursework: Some evidence exists that teacher math coursework may improve student achievement for high school students, but no such evidence exists for other subjects.
        - Limited research exists for the relationship of field experience to student achievement and none describes what specifically about field experiences relates to achievement. Most studies of field experiences rely on teacher's perceptions of changes in their practice due to fieldwork.
        - The authors conclude that the paper finds "an initial indication that pre-service preparation can influence teacher effectiveness, particularly the effectiveness of first-year teachers" (Boyd et al., 2007, 29).

    - The paper also found that research on teacher certification exams relate generally positively to student achievement, with three studies in particular that use rich data finding that exam scores were indicative of improved student achievement, but to a lesser degree than experience.
    - The paper concludes that research on more easily measured attributes of teacher preparation, such as degree attainment, is more plentiful, but "what is most remarkable today is the lack of evidence on the effect of almost any aspect of teacher preparation on the performance of students" (Boyd et al., 2007, 59).
- Notes/Ideas/Insights:
    - The paper provides a review of major research on teacher preparation and value-added student achievement, noting methodological deficiencies and highlighting stronger studies. While the discussion is brief, it provides a good overview of major themes in the research, including content coursework, pedagogical coursework, and field experience.
    - The paper also provides a quick review of major trends in alternative and traditional preparation programs with a state-by-state breakdown, but as noted by the scholars, program design varies greatly even within states.

Boyd, D.J., P. Grossman, H. Lankford, S. Loeb, N.M. Michelli and J. Wyckoff. (2006). Complex by design: Investigating pathways into teaching in New York City schools. *Journal of Teacher Education* 57, 155-166.

- Type of Study: Quantitative
- Data Sources:
    - The study includes data on 100 teacher preparation programs at sixteen colleges as well as five alternative certification pathways, all in New York state.
    - Student achievement data consists of student test scores for grades 4-8 from 1999-2000.
- Study Design: The study uses linear regression analysis to examine the value added to student test scores by five characteristics of program quality: program structure, math and reading subject-specific preparation, pedagogical preparation, knowledge in teaching diverse student populations, and field experiences. The study controls for student, teacher and school fixed effects.
- Summary and Results:
    - The study's purpose is "to examine pathways into teaching systematically to understand better how the characteristics of these pathways affect the quality of the teaching workforce in terms of the individuals who are attracted to teaching and the skills they acquire during their preparation, as well as effects on student achievement" (Boyd et al., 2006, 158).
    - This paper does not include the findings of the study, which at the time of publication were to be forthcoming (See Boyd et al., 2008 for the findings).
- Notes/Ideas/Insights:
    - While this paper does not actually carry out the study, it provides more detail on the study design as well as potential methodological problems for examining teacher preparation programs, including the assumption often

made by studies that all certification or preparation programs of a general type may be similar, and that pathway types (such as alternative certification pathways) may be comparable across states.
    - The study also suggests some possible characteristics of teacher preparation that previous scholars have identified as important.

Boyd, D., P. Grossman, H. Lankford, S. Loeb, and J. Wyckoff. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis 31*(4), 416-440.

- Type of Study: Quantitative
- Data Sources:
    - New York City Dept of Education student data (grades 3-6 primarily) matched with teacher administrative and program data for 31 teacher preparation programs (26 traditional plus NYC Teaching Fellows and Teach for America).
    - Program characteristics data was compiled from state documents, program descriptions, NCATE documents, websites, course syllabi and interviews with program directors.
- Study Design: The study uses regression analysis to estimate value-added to student learning by institution, program characteristics, and teacher perceptions of preparation programs, controlling for student, school and teacher fixed effects.
- Summary and Results:
    - This study seeks to determine if differences exist across teacher preparation institutions in value-added to student achievement, if program characteristics of preparation programs affect teachers' value-added for student achievement, and if teachers' perceptions of teacher preparation experiences affect their value-added.
    - The study has two main findings:
    - Institution characteristics: High value-added institutions can add the equivalent of one extra year of teaching experience.
    - Program characteristics:
        - The practice effect: teacher preparation that focuses on classroom work and gives teachers the opportunity to practice what they will actually be doing (such as capstones, oversight of student teaching, actual practice with classroom duties, reviewing curriculum they will work with) leads to more effective teachers in the first year of teaching.
            - Yielded 0.02 to 0.06 standard deviations improvement in student achievement in math; positive improvement in English Language Arts as well, but not consistent.
        - The field experience effect: field experiences and a student teaching placement in the field they will work in leads to more effective math and English Language Arts first year teachers.
            - Yielded 0.03 to 0.06 standard deviations improvement in student achievement.
        - Math content work improves teacher value-added for second year teachers.

        - Learning how students learn (through special coursework in how ELL students or students with disabilities learn) did not affect teacher value-added for first or second year teachers.
    - The authors conclude that the paper finds "an initial indication that pre-service preparation can influence teacher effectiveness, particularly the effectiveness of first-year teachers" (Boyd et al., 2008, 29).
- Notes/Ideas/Insights:
    - The paper offers several important caveats, including that program measures may estimate effects for unmeasured characteristics rather than the variable in question, that the data may not have sufficient variation (for example there are few low prepared teachers in New York because alternative certification standards in the state are so high), that measures of program characteristics may not be validated, and that the study may not examine differences in the importance of certain program characteristics for middle or high school teachers.
    - The study also suggests some general problems of value-added work: the fact that many other factors affect student learning, and that student achievement tests may not provide an accurate measure of educational attainment. These and the caveats above suggest some caution in concluding results to be robust or definitive.
    - The paper also suggests some reason to believe the effect sizes may actually be much larger, noting, "effect sizes estimated relative to the standard deviation of overall student achievement and with measurement error are roughly one quarter as large when measured relative to student achievement gains adjusting for measurement error. Thus, making such an adjustment increases estimated effect sizes presented in this paper by a factor of four" (Boyd et al., 2008, 27).

Cochran-Smith, M. and K.M. Zeichner, eds. (2005). *Studying teacher education: The report of the AERA panel on research and teacher education*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

- Type of Study: Meta-analysis
- Data Sources:
    - Based on the criteria used in Wilson et al. (2001) to select studies, the AERA panel employed criteria that required rigor for each type of study, for example multiple regression studies were expected to control for student characteristics and longitudinal studies were required to check for the effects of attrition (Cochran-Smith and Zeichner, 2005, 61).
- Study Design: The study examines eight main research topics, including demographic characteristics of teachers, characteristics of teachers that relate to teacher quality, subject matter and educational coursework, field experiences, pedagogical techniques, preparation to work with diverse student populations, preparation to work with students with disabilities, research on accountability processes such as certification and accreditation, and research on teacher education programs. The meta-analysis noted where the topics were studied in relation to student achievement and also included other outcome variables, such as teacher self-efficacy.

- Summary and Results:
    - This study seeks to provide a comprehensive and balanced review of the research on practices in preservice teacher education in the U.S.
    - The study has several main findings for each research question. Those findings that relate to student achievement are enumerated here:
        - Subject matter preparation: Little research exists on this topic except in math, where the general conclusion is that subject matter courses related positively to student achievement. However, which courses or what specific content is important is unknown.
        - Field experiences: The authors suggest a "cautious but positive conclusion that methods courses and field experiences can impact prospective teachers' thoughts about practice and in some instances actual teaching practices" (Cochran-Smith and Zeichner, 2005, 323). However, the studies do not examine a link to student achievement, relying mainly on teacher perceptions and occasionally on observations of teachers in the classroom but usually only during the experience, not after when they are full teachers.
        - Pedagogical techniques: The studies included do not relate the various techniques analyzed to the performance of teachers in the classroom or student learning.
        - Accountability policies:
            - Teacher testing: Teacher testing studies do not find positive correlation between teacher test scores and student achievement, but do find positive correlation with teacher characteristics like undergraduate GPA. Thus, teacher tests do have predictive validity of teacher effectiveness. The base of this literature uses the NTE test as well, which is no longer used.
            - Teacher certification: the certification literature suggests that teachers with traditional certification (as opposed emergency) have a positive correlation to student achievement, but the differences between certification types, even within the same general type such as emergency certification, vary widely across states.
        - Alternative certification: Alternative certification studies generally find alternatively prepared teachers to be as effective as "the average first year teacher" but the meaning of this comparison is limited based on the evaluators' varying perceptions of first-year teachers (Cochran-Smith and Zeichner, 2005, 674). Moreover, the studies supply relatively little information about the programs' characteristics and which particular characteristics may relate to student achievement.
    - The authors conclude with a research agenda for the field that is multidisciplinary and multimethodological, connects teacher education and student learning, examines more subject areas, and examines more systematically preparation alternatives and their characteristics. The

authors then provide a variety of topics for subsequent research (Cochran-Smith and Zeichner, 2005, 746).

- Notes/Ideas/Insights:
    - The meta-analysis often notes that the research fails to control for the differences teacher candidates bring to preparation programs. For example, it could be that math coursework is not improving student achievement, but simply that teachers that take more math coursework are more motivated, more intelligent, or have a greater love of math that improves their math students' learning.
    - In general the study sums up the limitations of the research currently by stating, "we will never be able to identify the features of effective teacher education programs in terms of any measures of teacher quality or pupil learning without close study of the characteristics teachers bring to their programs, of the complexities of programs as they are actually implemented, of what students learn from their programs, and of the schools in which they teach" (Cochran-Smith and Zeichner, 2005, 697).

Goldhaber, D. (2007). Everyone's doing it, but what does teacher testing tell us about teacher effectiveness? *The Journal of Human Resources* 42(4), 765-94.

- Type of Study: Quantitative
- Data Sources:
    - Linked administrative data of student test scores from grades 4-6 and teacher Praxis II content and curriculum test scores in North Carolina from the 1994-1995 through 2003-2004 school years.
- Study Design: The study uses regression analysis to estimate value-added to student achievement by two types of teacher licensure exams, controlling for school and student fixed effects.
- Summary and Results:
    - This study seeks to examine the relationship between teacher licensure content and curriculum scores and student achievement, as well as the effect of raising licensure standards on screening out effective teachers (i.e. those who add value to student achievement).
    - The study has two main findings relating to teacher preparation:
        - Praxis II Curriculum, Assessment and Instruction scores are positively related to student achievement, leading to a gain of 0.022 in reading and 0.035 in math from the bottom quintile scorers to top quintile scorers of teachers.
        - Praxis II Content scores does not add value to student achievement.
    - The author concludes that "licensure tests are predictive of teacher effectiveness, particularly in teaching mathematics, and the finding is robust to alternative specifications of the model, including specifications that account for nonrandom sorting of teachers across students" (Goldhaber, 2007, 788).
- Notes/Ideas/Insights:
    - The findings suggest that knowledge of curriculum planning, assessment of student learning, and other teaching skills may be more important than content knowledge for student achievement.

- While the study suggests that nonrandom teacher sorting and attrition may bias the results, the author ultimately concludes that licensure scores still function as a signal of teacher effectiveness despite the potential for bias.
- Additionally, the paper cautions that raising such licensure standards (based on a test artificially raising cut scores to Connecticut levels) may increase the contribution to student achievement of low achieving teachers while not affecting the proportion attributed to high achieving teachers. Thus, licensure tests as a form of teacher preparation have both costs and benefits for student achievement.

Goldhaber, D.D. and D.J. Brewer. (1997). Evaluating the effect of teacher degree level on educational performance. In *Developments in School Finance*, ed. W. J. Fowler, 197-210. Washington, D.C.: National Center for Education Statistics, U.S. Department of Education.

- Type of Study: Quantitative
- Data Sources:
  - NELS:88 individual student-level achievement and administrative data that links tenth grade students to both classrooms and teachers.
- Study Design: The study uses OLS regression analysis to estimate value-added to student achievement by subject-specific degrees held by teachers and analyzed separately for history, math, science and English.
- Summary and Results:
  - This study seeks to examine the relationship between subject-specific degrees of teachers and student achievement.
  - The study has two main findings relating to teacher preparation:
    - Math: Holding a math BA, MA, or math certification has statistically significant and positive results for student achievement relative to teachers without subject-specific degrees or certification. The effect size is about 5% of a standard deviation when a BA, MA *and* certification are held in math, with smaller values for one stage only. A positive relationship is also found for science BA degrees.
    - No relationship is found for English or history subject-specific degrees or certification.
  - The authors conclude, "that student achievement in technical subjects can be improved by requiring in subject teaching." (Goldhaber and Brewer, 1997, 208).
- Notes/Ideas/Insights:
  - The study ran a check that indicated the math and science degrees and certifications are not just proxies signaling teacher ability by testing them in the English and history regressions, thus such subject-specific coursework is leading to improved student achievement.
  - Kukla-Acevedo (2008) suggests that Goldhaber and Brewer's (1997) data cannot link individual students to teachers and thus cannot control for the nonrandom sorting of teachers and students into classrooms. Kukla-Acevedo (2009) corrects for this in her similar examination of math subject-specific preparation.

    - Despite these findings, other meta-analyses included here have indicated that the specific content of such preparation within the subject area may influence the effectiveness of such preparation.

Kim, M.M., R.L. Andrews, and D.L. Carr. (2004). Traditional versus integrated preservice teacher education curriculum. *Journal of Teacher Education* 55(4), 341-356.

- Type of Study: Quantitative comparative case study
- Data Sources:
    - A survey of 334 students in a preservice preparation program at a Midwestern state university college of education (possibly MU due to authors' affiliations) before and after curriculum changes were instituted in 1999.
- Study Design: The study compares completers before the curriculum change to completers of the integrated curriculum design that enrolled under the traditional system (thus eliminating selection bias) and examines differences in perceived effectiveness on the thirteen integrated curriculum's principles using two-way multivariate analysis of variance (MANOVA).
- Summary and Results:
    - The study examines whether students under the traditional (discrete courses) and integrated curriculums (interdisciplinary and correlated courses) perceive different levels of preparedness for teaching upon completion in thirteen different areas.
    - The paper has one main finding relating to teacher preparation characteristics:
        - Students in the integrated curriculum feel consistently more prepared across all principles measured (such as content, curriculum, actual lessons, etc.) regardless of major.
    - The authors' main conclusion is that the integrated curriculum may be a promising reform for teacher preparation programs to help students achieve professional competencies.
- Notes/Ideas/Insights:
    - The study is typical of the designs commonly used to examine teacher preparation programs, comparative case studies that measure perceptions of preparedness or effectiveness rather than student achievement. Despite this drawback, the study is included here as an example of this type of analysis of teacher preparation as well as because it was completed on a Missouri teacher preparation program and analyzes a unique program characteristic: the integrated curriculum.

Kukla-Acevedo, S. (2009). Do teacher characteristics matter? New results on the effects of teacher preparation on student achievement. *Economics of Education Review* 28, 49-57.

- Type of Study: Quantitative
- Data Sources:
    - Unique student level dataset that matches teachers with 5th grade math students in one school district in Kentucky from 2000-2003.

- Study Design: The study uses fixed effects models to estimate value-added to student achievement by subject-specific preparation in math.
- Summary and Results:
    - This study seeks to examine the relationship between student achievement and subject-specific preparation, measured as hours of math content and math education coursework taken, math GPA, math education GPA, and overall GPA. The study also seeks to examine whether the effects of the measures vary with teacher experience.
    - The study has four main findings relating to teacher preparation:
        - Math education GPA is initially negative across all student data, but the effects grow positive over time.
        - Math content hours are positive and grow as time goes on, indicating teachers with high math content hours are initially more effective than other teachers and their effectiveness grows as they gain experience.
        - Math education hours has the largest effect sizes of any preparation variable, but does not become positive until teachers have ten to fourteen years of experience.
        - Effects of preparation characteristics differ across racial subgroups. African-Americans are positively impacted by overall GPA and math content hours, while European Americans do not have statistically significant effects.
    - The author concludes that the findings "provide support that both content and pedagogical knowledge are important to effective teaching." The author states, "all else equal, a teacher who took 11 h of math content will have higher student math scores than a teacher who took 10 h of math content and will have incrementally higher student math scores over the years" (Kukla-Acevedo, 2009, 55-6).
- Notes/Ideas/Insights:
    - The study finds significant support for content and pedagogical education, something which several earlier studies were unable to parse out by examining simply major in the subject area and including both math education and math majors in this category.
    - The study also finds that the effects of such preparation are magnified over time, suggesting their importance for teacher preparation program design. However, some measures may not be positive in the first years, and may take a long time to reap benefits for student achievement.
    - Despite positive findings, the study measures the relationship for only one school district in the U.S. and thus the results may not be generalizable to all student populations.

Monk, D.H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review* 13(2), 125-145.

- Type of Study: Quantitative
- Data Sources:
    - Longitudinal Survey of American Youth data on tenth grade student achievement linked to math and science teacher preparation characteristics from 1987-1990.
- Study Design: The study uses linear regression to estimate value-added to student achievement by subject-specific preparation in math and science.
- Summary and Results:
    - This study seeks to examine the relationship between student achievement and subject-specific preparation, measured as undergraduate and graduate subject-specific coursework and degree completion.
    - The study has a range of findings in both math and science:
    - Math:
        - Number of hours of math content undergraduate coursework has a positive relationship to student achievement, a 1.2% increase in student test scores at the mean for juniors, and 0.2% for sophomores. Graduate coursework is also positive for sophomores.
        - The relationship between number of math content courses and student achievement appears to be curvilinear. After five math content courses, the gain drops from 1.2% to 0.2%.
        - Number of hours of math education undergraduate coursework has a positive relationship to student achievement, with a 0.4% increase in student test scores at the mean. Graduate coursework is also positive for sophomores. The author also notes that the difference in gains is significant at the 0.01 level, concluding that math education coursework is more important than content coursework for student value-added.
        - Majoring in math has no effect.
        - Interaction effects: Number of math courses taken has a positive effect on students in AP courses, and no effect on students in remedial courses.
    - Science:
        - Number of hours of life sciences undergraduate coursework has no relationship to student achievement for sophomores, and only positively affects juniors' achievement after teachers attain six life sciences courses.
        - Number of hours of physical sciences undergraduate coursework has a positive relationship to student achievement for sophomores, and juniors after teachers attain four physical sciences courses.
        - Graduate level life sciences coursework is positive for juniors, however physical sciences graduate work is negative.
        - For science education courses, graduate education has a positive relationship to student achievement in the sophomore year, while undergraduate education has a positive relationship in the junior year.

        - Effect sizes double for pedagogy courses compared to content courses, at 0.8% as compared to 0.4%.
        - Majoring in science has a positive effect at the junior level beyond taking coursework in science or science education.
        - Interaction effects: Number of math courses taken by teachers in the physical sciences has a positive effect on student achievement, suggesting training in math may be beneficial for physical science teachers.
        - In both math and science specifications, having a graduate degree (not considering major) does not have positive effects on student achievement.
    - The author concludes that subject specific preparation matters, though the relationship is not always linear and sometimes exhibits threshold effects. Pedagogical coursework is also found in several cases to be more important than content coursework. However, the author notes that "the effect of teacher subject matter knowledge appears to depend on the subject being taught, the characteristics of the students being taught, as well as on additional attributes of the teacher" (Monk, 1994, 142).
- Notes/Ideas/Insights:
    - Monk (1994) is the seminal study in subject-specific coursework research and finds a variety of positive relationships between subject area preparation and student achievement. The study is still relevant today because it separates content and pedagogical coursework and is one of the only studies to indicate thresholds and a curvilinear relationship, suggesting some in grades and subjects teachers may need several courses to become effective, and that advanced training may not always be beneficial.
    - However, as Monk (1994) notes, the study only provides counts of courses and cannot determine the quality or content of such coursework. Some courses are inevitably better than others. Moreover, the coursework counts are self-reported and thus subject to distortion.

Noell, G.H., B.A. Porter, R.M. Patt, and A. Dahir. (2008). *Value added assessment of teacher preparation in Louisiana*. Baton Rouge, LA: Louisiana Board of Regents. http://regents.state.la.us/Academic/TE/2008/Final%20Value-Added%20Report%20%2812.02.08%29.pdf

- Type of Study: Quantitative
- Data Sources:
    - Unique student level dataset that matches teacher data from 22 public and private teacher preparation programs with test scores on state achievement tests in math, science, social studies, language arts, and reading of fourth through ninth grade students in public schools in Louisiana from 2004-2007.
- Study Design: The study uses hierarchical linear modeling to estimate value-added to student achievement by specific teacher preparation programs, teacher ACT subject scores, and teacher certification status.
- Summary and Results:

    - This study seeks to examine if differences in the effectiveness of teacher preparation programs can be found using student achievement data in Louisiana.
    - The study has four main findings relating to teacher preparation:
        - The study identifies student achievement in specific content areas at individual teacher preparation programs by comparing whether the programs met, exceeded, or failed to meet achievement gains by other new teachers or experienced teachers. These specific findings could be used to target content knowledge areas for improvement within individual programs.
        - ACT math scores are modest predictors of success in mathematics.
        - Students of teachers certified in the content area they teach perform better than students of teachers that are not certified, have temporary certification status, or are certified out of subject.
    - The author concludes that, "the data suggest that differences in TPP effectiveness are detectable using data pooled across multiple school years" (Noell et al., 2008, 40).
- Notes/Ideas/Insights:
    - The study supports findings that content specific certification relates positively to student achievement and also suggests that entry requirements such as ACT scores may matter for the success of preparation programs in creating high quality teachers.
    - The study also creates a way for specific programs to improve their content directly based on student achievement data, something that could be beneficial in other states considering the variety across programs even within content areas that currently exist.
    - The next stage of this multi-year study plans to investigate the "degree to which program characteristics are associated with their impact on student attainment" (Noell et al., 2008, 40). These findings should be of interest to the subject of this report.

Rowan, B., F. Chang, and R.J. Miller. (1997). Using research on employees' performance to study the effects of teachers on student achievement. *Sociology of Education* 70(4), 256-284.

- Type of Study: Quantitative
- Data Sources:
    - NELS:88 data on tenth grade student test scores in math and matched teacher data.
- Study Design: The study uses hierarchical linear modeling to estimate value-added to student achievement by three measures of teacher quality.
- Summary and Results:
    - This study seeks to examine the relationship between student achievement and teacher quality and motivation, with teaching ability measured as undergraduate major, teacher score on a math skills test, and teacher's use of higher-order thinking instruction.
    - The study has three main findings relating to teacher preparation:

        - Both teacher score on a math skills test and whether the teacher has an undergraduate degree in math relate positively to higher student achievement, 0.02 and 0.015 standard deviation gains respectively.
        - Higher-order thinking is not significant but covaries in the same direction as other measures, which the authors note might indicate that it measures the same thing as the course-taking control variable.
        - The authors note that the effects vary depending on the ability of students in the school.
    - The authors conclude that the findings "provide preliminary support for the broad hypothesis that teaching performance is a function of various dimensions of teachers' ability, motivation, and work situation" (Rowan et al., 1997, 272).
- Notes/Ideas/Insights:
    - The study suffers from several limitations, including that it evaluates only one of the teachers the students learned math from, while students learn from several teachers in each subject over the course of their high school career. The study also uses crude proxies in some cases for teacher preparation characteristics, especially for the basic skills test, which uses only one survey item from NELS:88, "teacher's score on the math quiz" (Rowan et al., 1997, 265).
    - Despite these shortcomings, the study supports other evidence that content preparation matters, from basic skills in the subject area to a degree in the subject.

Wayne, A.J. and P. Youngs. (2003). Teacher characteristics and student achievement gains: A review. *Review of Educational Research* 73(1), 89-122.

- Type of Study: Meta-analysis
- Data Sources:
    - The paper includes 21 studies of value added by teacher characteristics to student achievement.
- Study Design: The review's includes only studies that measure teacher characteristics and use standardized test scores of the teachers' students, use U.S. data, control for past achievement, and control for student socioeconomic status.
- Summary and Results:
    - The review examines studies of teachers' college ratings, test scores, coursework and degrees, certification status, and a brief review of other measured characteristics of teachers, such as race and years of experience.
    - The paper has three main findings relating to teacher preparation characteristics:
        - Licensure exams: The review concludes that students learn more from teachers with higher test scores on teacher licensure examinations (the relevant studies are Ferguson, 1991, 1998 and Summers and Wolfe, 1975, 1977).
        - Subject specific coursework: The review concludes that math students in high school learn more from teachers with bachelors or master degrees in math as compared to nonmathematic subjects,

and from teachers who have taken coursework in math (the relevant studies are Goldhaber and Brewer, 1997, 2000, Eberts and Stone, 1984, Rowan et al., 1997, and Monk and King, 1994). One study cited above in this report finds similar results for science bachelor degree-holders (Goldhaber and Brewer, 1997).
        - The review concludes that standard certification in math leads to student achievement gains when compared to those with no certification or private school certification in math (the relevant study is Goldhaber and Brewer, 1997).
    - The paper concludes licensure examinations, subject specific coursework, and certification in specific subjects have been found to lead to student achievement gains for some groups of students.
- Notes/Ideas/Insights:
    - While the review suggests licensure exams may be an important element for teacher preparation, the exams studied in this review are no longer in use and do not specify the type of knowledge (content-based, pedagogical, or basic skills) being tested and which exam type is related to student achievement.
    - Related to subject area coursework, the review notes that the studies do not distinguish between subject coursework and courses that prepare teachers how to teach a specific subject, a distinction that may be significant for preparation standards.
    - Overall, the review summarizes the relevant research on several important teacher characteristics, noting where individual student-level data was used (in most cases), but does not discuss effect sizes and relies on relatively older data, such as NELS:88 and LSAY data from the 1980's. Thus, more updated research to account for changes in teacher preparation and the teaching workforce in general may be necessary. Additionally, effect sizes are key in determining the relative importance of noted gains.

Wenglinsky, H. (2002). How schools matter: The link between teacher classroom practices and student academic performance. *Education Policy Analysis* 10(12), retrieved from http://epaa.asu.edu/epaa/v10n12/.

- Type of Study: Quantitative
- Data Sources:
    - 1996 NAEP data of eighth grade student test scores and linked teacher data.
- Study Design: The study uses multilevel structural equation modeling (MSEM) to separate student and school level effects and analyze the relationship between and among the three measures of teacher quality (see below) and student achievement.
- Summary and Results:
    - This study seeks to examine the relationship between student achievement and three aspects of teacher quality: classroom practices, professional development and teacher preparation characteristics.
    - The study has four main findings:

        - Of the 21 classroom practices measured, only three have positive relationships to student achievement: hands-on learning, solving unique problems and avoiding reliance on authentic assessments.
        - Of the ten professional development measures, only two have positive relationships: addressing special populations of students and higher-order thinking skills.
        - One teacher preparation characteristic is positively associated with student achievement: teacher major.
        - The findings seem to reinforce each other; for example, schools with more teachers with a major in their subject area spend more time on professional development and teachers that spend more time on the key professional development findings exhibit the key classroom practices noted to correlate to student achievement.
    - The author concludes that the findings confirm their hypotheses that classroom practices have the greatest effect, followed by professional development and teacher characteristics, resulting respectively in total effect sizes of 0.56, 0.33 and 0.09 for the three categories.
- Notes/Ideas/Insights:
    - Though the findings measure teacher practices after teachers begin to teach, the positively correlated practices may signal specific content that should be included in teacher preparation programs. Since the actual content of pedagogical courses is often not examined in detail in student achievement studies, the specific classroom practices examined here may fill this gap and thus the study is included in this review.
    - Findings for the variables of interest are aggregated to the school level, thus student fixed effects may not be adequately controlled for. Moreover, the study notes several methodological limitations, including survey practices, testing students at the same and thus an inability to establish a causal direction, and using poor proxies for some variables, specifically socioeconomic status.

Wilson, S.M., R.E. Floden, and J. Ferrini-Mundy. (2001). *Teacher preparation research: Current knowledge, gaps, and recommendations*. Seattle, WA: Center for the Study of Teaching and Policy.
http://depts.washington.edu/ctpmail/PDFs/TeacherPrep-WFFM-02-2001.pdf.

- Type of Study: Meta-analysis
- Data Sources:
    - 57 studies of teacher preparation based on the criteria outlined below.
- Study Design: The review includes only studies that are peer-reviewed empirical U.S. studies published in the last 20 years that directly relate to the five teacher preparation questions posed the U.S. Department of Education (see summary below) and meet six standards for rigorous research outlined in the report appendix.
- Summary and Results:
    - This study seeks to examine five major issues in teacher preparation: subject matter preparation, pedagogical preparation, student teaching,

successful reform strategies that have been implemented, and characteristics of high-quality alternative certification programs.
    - The study has five main findings:
        - Subject-matter preparation: Subject knowledge matters for student achievement, but there may be a point at which more knowledge is no longer beneficial, thus the evidence on the value of a major in the subject area is mixed. Subject-specific education coursework appears to matter, and one study found it mattered even more than subject-area coursework.
        - Pedagogical preparation: Pedagogical coursework appears to matter more to student achievement than other teacher characteristics, such as GPA, major, or subject-area coursework, but studies cannot provide details about the specific content of such courses.
        - Field experience studies included are all interpretive designs and measure shifts in teacher attitudes rather than student achievement.
        - No studies included bear directly on the relationship between implemented state policies on teacher preparation and student achievement, though analyses of certification exam scores could fall into this category and find a positive relationship with student achievement.
        - Only one of the eleven studies included on alternative certification focuses on value-added to student achievement and, comparing an alternative program with extensive coursework and mentoring to traditional pathways, finds no difference for student achievement between the pathways.
- The authors conclude that more research is warranted on teacher preparation, especially on specific designs of program attributes like subject matter preparation, field experience, and alternative certification pathways.
- <u>Notes/Ideas/Insights</u>:
    - While the review summarizes the work of included studies, the report does not clearly synthesize the literature base or provide more detailed information about specific findings, such as whether student achievement or other measures are used to measure effectiveness. Moreover, the review reports no relevant findings to value-added student achievement for student teaching or successful state policies.
    - The review notes that subject-matter knowledge studies are often contradictory because they rely on proxies such as coursework or major that may have significant variation across programs rather than direct measures of knowledge. This is significant for interpretation of other studies of subject matter preparation included in this report.
    - The findings for alternative certification suggest that preparation that is more extensive may be important for student achievement, but the finding does not negate the possible conclusion that alternate routes with less preparation may be equally as effective since it does not examine any such programs.

- The study also notes that effectiveness of various preparation characteristics may vary across grade levels, but research comparing such differences is not yet available.

Table Summarizing Other Teacher Preparation Studies

Teacher preparation studies cited in Wilson et al. (2001) and Allen (2006), by topic				
Author	Dataset	Dependent Variable	Independent Variable	Finding
Subject Matter and Pedagogical Preparation				
Chaney (1995)	NELS:88	Student test scores in science, math, reading and history	Major or minor undergraduate and graduate subject area Pedagogical coursework Undergraduate or graduate degree in subject area	Pedagogical coursework was only helpful if it is also in the subject area (i.e. math education). Students of teachers with undergraduate or graduate majors in math had higher mean math scores. Students of teachers with a graduate major in science had higher mean science scores. 8th grade math scores were higher for students whose teachers had undergrad or graduate degrees in math.
Darling-Hammond (2000)	NAEP	State average scores- math grade 4 in 1990, 1996 and grade 8 in 1992, 1996; reading grade 4 in 1992, 1994	Certification status and major or minor in their field	Positive correlation (both math and reading) with both major in field and full certification, negative correlation with less than a minor in field or less than full certification.
Darling-Hammond, Berry, and Thorenson (2001)	NELS:88	10th and 12th grade student test scores in	Education degree (BA, MA, minor or education specialist) Subject area degree (BA, MA, minor or education specialist)	Both education degree and subject area degree had positive effects on scores, but were not statistically significant at the 0.05 level.
Druva and Anderson (1983)	Meta-analysis of 65 studies of K-12 science teachers	Student achievement	Number of biology courses Number of science courses Attendance at academic institutes Education coursework	Positive correlations for variables listed to the left. The correlation increased with the level of the science course.

Eisenberg (1977)	Sample of 28 junior high teachers and their students in Ohio	Student tests scores on math inventory I-IV tests, Short Form Test of Academic Aptitude (SFTAA), and California Comprehensive Test of Basic Skills (CCTBS) Student GPA (math and English)	Math content knowledge measured by Algebra Inventory Form B examination Number of postcalculus math courses College math GPA	No measures of subject matter preparation were significantly correlated with student achievement.
Fetler, M. (1999).	California's Standardized Testing and Reporting Program (STAR)	Stanford 9 math test scores (school averages)	Certification in subject area status (standard or emergency) Education level but no data on major	Negative correlation between the percent of teachers with emergency mathematics certification and student math achievement.
Ferguson and Womack (1999)	Original dataset of 266 secondary student teachers at Arkansas Tech University	Teaching performance measured as ratings by students' education supervisors and subject matter specialists	Education coursework grades Major GPA NTE Specialty scores	Education coursework accounted for 48% (supervisor rating) and 39% (specialist rating) of variance. Subject matter major and NTE scores accounted for 9% and 1%.
Goldhaber and Brewer (2000)	National Educational Longitudinal Study 1988 (NELS:88)	10^{th} and 12^{th} grade standardized test scores in math and science	Certification status (standard subject, probationary subject, private school, none) Degree in subject area Major in subject area Degree in education	Standard and private school certification and degree in subject area (BA and MA) had a positive relationship to math scores. Subject matter major and degree education had no relationship to science scores. BA in education had negative relationship to math scores.

Guyton and Farokhi (1987)	Original dataset of graduates from Georgia State University 1981-84	Georgia Teacher Performance Assessment Inventory Certification (subject matter) test scores	Regents Tests of Basic Skills GPA in education courses	Basic skill ability was correlated with certification scores but not the teacher performance assessment. GPA in education courses was correlated with the performance assessment. Certification scores were not correlated with performance assessment.
Hawk, Coble and Swanson (1985)	Original dataset of 36 graduates of E. Carolina Univ. and 826 students	Stanford Achievement Test (general math) and Stanford Test of Academic Skills (algebra)	Teacher field (in-field vs. out-of-field)	Students with in-field teachers scored higher on both tests.
Hawkins, Stancavage and Dossey (1998)	NAEP	4^{th} and 8^{th} grade student tests scores in math	Major in subject area Major in subject area education Major in education Certification in subject matter	4^{th} graders whose teachers had a college major in math, math education or education scored better than students whose teachers majored in another field. Students of math majors scored lower than students of education majors. 8^{th} grade students of math majors did better than students whose teachers majored in education or another field. Students whose teachers had a teaching certificate in math scored better than other 8^{th} graders.

Rowan, Correnti, and Miller (2002)	Prospects Study of Elementary Schools	3rd grade and 6th grade students' IRT scale scores on the Comprehensive Tests of Basic Skills (CTBS) reading and math tests	Undergraduate or advanced degree in subject area Special certification in subject area	For reading, teacher degree or certification in subject area had no effect. Students taught by a teacher with an advanced math degree scored better than students of teachers without a math degree. Math certification had no effect on scores.
Schelske and Deno (1994)	26 student teachers at a 4-year private liberal arts college in Minnesota	Teacher effectiveness measured as: Student Teacher Evaluation Scale, Student Engagement Ratings Scale, component rating scales, and classroom observations	The participants were randomly assigned to three seminar conditions: coping skills, classroom management, and educational discussion.	Student teachers in the classroom management and coping skills seminars had high classroom management skills, higher faculty ratings of effectiveness, and lower percentages of pupil off-task behavior than student teachers in the discussion seminar.
Interpretive studies based on teacher perceptions and beliefs are not included in this table. All had fewer than 15 participating teachers. See Wilson et al. (2001) for more on Adams and Krockover (1997), Gess-Newsome and Lederman (1993), Grossman (1989), Grossman and Richert (1988), Grossman et al. (in press at time of publication), Hollingsworth (1989), and Valli and Agostinelli (1993). Not included in this table from Allen are 26 studies that were descriptive analyses, as well as Cornett (1984) and Denton and Lacina (1984), none of which measured student achievement.				
Field Experience				
Metcalf, Hammer, and Kahlich (1996)	7 teacher candidates in general methods courses at a preservice preparation program	Ability to identify and explain pedagogical events Ability to organize instruction (Measured by performance on work including papers, daily logs, video of them teaching mini-lessons)	Teacher candidates took part in either a laboratory experience on campus to role-play field scenarios or a field experience.	Teachers in the laboratory experience improved ability to identify and explain pedagogical events, whereas field experience teachers worsened. No difference in ability to organize instruction across the groups.
Interpretive studies that involved mainly description of field experiences or interviews with teachers about perceptions of changes efficacy are not included in this table. None of these studies addressed quantitative measures of student achievement. See Wilson et al. (2001) for more on Borko et al. (1992), Carter and Gonzalez (1993), Clift (1991), Eisenhart et al. (1992), Eisenhart et al. (1991), Florio-Ruane and Lensmire (1990), Goodman (1985), Griffin (1989), Grisham et al. (2000), Grossman and Richert (1988), Grossman et al. (in press at time of publication), Hollingsworth (1989), Lazar (1998), Shulman (1987), Tabachnick et al. (1979-1980), Tabachnick and Zeichner (1979-1980), and Wilson (1996). Allen did not include any studies of field experiences related to student achievement, but did include 19 descriptive studies not enumerated here.				

Alternative Teacher Preparation				
Clewell and Villegas (2001)	Sample of 1,500 participants from 40 Wallace-Reader's Digest-funded Pathways to Teaching Careers preparation programs	Ratings of teacher effectiveness by peers, mentors and principals Praxis III scores (in-service teacher assessment)	Teacher preparation route (emergency certification or Peace Corps alternative routes vs. "typical novice teacher" in same schools) Both alternative routes involved several weeks of preservice training, ongoing mentoring, supervision and education coursework	Peace Corps teachers were rated more highly on teaching ability than emergency certified teachers, and both were rated more highly than typical novice teacher. A small group of alternative teachers had Praxis III scores equal to or higher than the typical novice teacher. The study identified 4 key factors that related to successful outcomes: strong preparation program-district partnership, careful recruitment and selection, a rigorous, innovative and culturally sensitive curriculum, and a variety of support for participants.
Goebel, Ronacher, and Sanchez (1989)	Sample of 177 participants in Houston's Alternative Certification Program, 192 experienced teachers and 158 fully certified first-year teachers	Student achievement	Teacher preparation route (alternative or traditional) Alternative teachers received preservice summer training and ongoing weekly training, observation of master teachers and supervision after beginning teaching	Little difference in student achievement across teacher preparation pathways. Pupils of the experienced teachers and alternative teachers with more experience did somewhat better than the students of first-year teachers and less-experienced alternative teachers.
Guyton, Fox and Sisk (1991)	29 teachers (3 alternative, 26 traditional) in Georgia	Beginning Teachers Evaluation Form (completed by mentors, peers and principals) The study also included several measures of self-efficacy that are not enumerated here	Teacher preparation route (alternative or traditional) Alternative teachers were in the Alternative Preparation Institute in Georgia	No significant differences in mean evaluations scores across the two groups.

Hutton, Lutz and Williamson (1990)	110 alternative teachers and 62 traditionally prepared teachers	Texas Teacher Appraisal System (TTAS) scores Examination for the Certification of Educators in Texas (ExCET) scores *Teacher Advisor Comparison Rating* Form (TACRF) scores The study also included several measures of self-efficacy that are not enumerated here	Teacher preparation route (alternative or traditional) Alternative teachers were interns in the Dallas Independent School District Alternative Certification Program	Alternative route teachers met or exceeded expectations on the TTAS Alternative route teachers scored higher in 5 of the 7 ExCET categories than traditional teachers.
Jelmberg (1996)	492 NH elementary and secondary school teachers	Principal evaluations The study also included several measures of self-efficacy that are not enumerated here	Teacher preparation route (alternative or traditional) Alternative teachers entered with no preparation followed by a 3 year professional development plan	Principals rated traditional teachers significantly higher on instructional planning and instructional skills.
Lutz and Hutton (1989)	110 alternative teachers and 62 traditionally prepared teachers	Texas Teacher Appraisal System (TTAS) scores Examination for the Certification of Educators in Texas (ExCET) scores Teacher Advisor Comparison Rating Form (TACRF) scores Basic skills test	Teacher preparation route (alternative or traditional) Alternative teachers were interns in the Dallas Independent School District Alternative Certification Program	Mentors rated 91.8% alternative teachers as performing as well as, or superior to the typical first-year teacher. 99 alternative teachers had higher ExCET scores than the statewide average of first-year teachers. Principals rated first-year teachers higher than alternative teachers on reading, discipline management, classroom management, planning, instructional techniques, and instructional models.
Miller, McKenna, and McKenna (1998)	41 alternative teachers and 41 traditional teachers in same grade level, subject and school	Iowa Test of Basic Skills (ITBS) scores of teachers' students The study also included several measures of self-efficacy that are not enumerated here	Teacher preparation route (alternative or traditional) Alternative teachers were in an 8th grade teacher prep program All teachers had 3 years of classroom experience	No difference in average student achievement.

Raymond, Fletcher, and Luque (2001)	Sample of 8,500 public teachers, and 117 Teach for America teachers in the Houston Alt. Certification Program	Texas Assessment of Academic Skills (TAAS) student test scores in math, reading, and English language arts for each year the student was enrolled in a Texas school	Teacher preparation route (alternative or traditional) Alternative teachers received TFA training and preservice summer training, ongoing training, observation of master teachers and in-service supervision	Test scores were slightly higher for students of TFA teachers (completing the Alt. Cert. Program), and had less variation between students.
Sandlin, Young, and Karge (1992-93)	59 alternative teachers and 66 traditional teachers	Teacher Evaluation Scale and classroom observation of teachers The study also included several measures of self-efficacy that are not enumerated here	Teacher preparation route (alternative or traditional) Alternative teachers were in a California University Intern Credential program with 2 years classroom experience	Alternative teachers were initially rated lower on 5 of the 16 items in the evaluation, but after a year, no differences existed between the groups.
Stoddart (1990)	Sample of 82 California alternative route teachers (including 77 L.A. Unified interns), 32 traditionally prepared teachers, 34 emergency certified teachers	Observations of teacher effectiveness by researchers from California Commission on Teacher Credentialing. Rated on six criteria: classroom environment, student involvement, presentation skills, content and method, classroom management, and cognitive activity	Teacher preparation route (alternative or traditional) Alternative teachers had a 2-week preservice orientation, followed by in-service coursework and training, and mentor support. Coursework was not rigorous and did not involve grading	Both groups had difficulty explaining mathematical concepts. Traditionally prepared English teachers were more knowledgeable about teaching writing. Alternative teachers had higher expectations for low-income and minority students. The instructional strategies of the alternative teachers were unresponsive to student needs. Alternative teachers had difficulty evaluating their instruction. Overall, alternative teachers lacked substantive content knowledge.
Studies not included in this section were interpretive studies focused on teacher perceptions of efficacy, program descriptions, or descriptions of demographics of alternative certification students. See Wilson et al. for more on Grossman (1989), Houston et al. (1993), McDiarmid and Wilson (1991), Shen (1997), Shen (1998a), and Shen (1998b), and see Allen for more on Darling-Hammond, et al. (1989), Hawk and Schmidt (1989), and Sandlin, et al. (1992-3).				

Program Structure				
Gitomer, Lathan, and Ziomek (1999)	Sample of over 300,000 teacher candidates who took the Praxis I and II examinations from 1994-97	Passage of Praxis I exam Percentage of teachers admitted to teacher preparation programs	Teacher SAT/ACT scores Praxis I teacher scores	Teachers that passed Praxis 1 had higher ACT/SAT scores than those who failed. A higher cut score on the Praxis resulted in higher ACT/SAT scores of admitted teachers, but fewer teachers qualified for admission.
Wenglinsky (2000)	Original sample of 152 institutions and 40,000 students	Praxis II exam scores	Proportion of the institution (budget and number of education students) focused on teacher preparation Proportion of traditional students Private or public status Faculty diversity	Teacher candidates did better on the Praxis II if the institution had a low proportion of the institution devoted to teacher preparation, had a high proportion of traditional students, were private, or had an ethnically diverse faculty.

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